**Verify that this is the correct version before use**

Compliance is Mandatory

# Design and Development

**Responsible Office: Engineering Directorate**

## TABLE OF CONTENTS

## LIST OF TABLES

## LIST OF FIGURES

# Change History Log

| Revision | Date | Originator | Description of Changes |
|---|---|---|---|
| Baseline | June 2007 | Mark D. Schmalz / x30131 | Initial Release. Convert SLP to JPR format. |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

# P. PREFACE

## P.1 PURPOSE

The purpose of this JPR is to establish a consistent method to control and verify the design and development of products to ensure the customer/requester's specified requirements are met.

## P.2 APPLICABILITY

This JPR is applicable to all JSC NASA organizations including Ellington Field and the Sonny Carter Training Facility except for the following:

a) White Sands Test Facility

b) Office of Inspector General

c) NASA Engineering and Safety Center Offices at JSC

JSC directives may apply to contractors or grant recipients only to the extent specified or referenced in the appropriate contracts, grants, or agreements.

## P.3 AUTHORITY

(All document citations are assumed to be the latest version unless otherwise noted.)

a) JPD 1280.1, Quality Policy

b) JPR 1280.2, Quality Manual

## P.4 APPLICABLE DOCUMENTS

(All document citations are assumed to be the latest version unless otherwise noted.)

Documents cited in the body of this JPR that contain provisions or other pertinent requirements directly related and necessary to the performance of activities specified by this JPR include these applicable documents:

a) JPR 1281.1, *Management Responsibility*

b) JPR 1281.6, *Procurement*

c) JPR 1281.9, *Process Control*

d) JPR 1281.10, *Inspection and Testing*

e) JPR 1281.17, *JSC Audits*

f) JPR 1440.3, *JSC Files and Records Management Procedures*

g) NT -CWI-001, *Task Performance Sheet*

**P.5 MEASUREMENT VERIFICATION:**

a) Processes and procedures shall be measured and monitored as prescribed by JPR 1281.9.

b) Audits, as prescribed in JPR 1281.17, shall be used to verify conformance with requirements.

c) Results shall be reviewed by Directorates and the Center as prescribed by JPR 1281.1.

**P.6 CANCELLATION / RESCISSION:**

Upon issuance of this JPR, SLP 4.4, Rev. F, Design *and Development,* dated June 2006, *is* cancelled.

*Original Signed By:*

H. Lawrence Dyer
Manager, Management Integration Office

Distribution:

JDMS

## 1.0 SCOPE

This JPR applies to the design and development of hardware and software projects at the NASA Johnson Space Center.

## 2.0 RESPONSIBILITIES

### 2.1 Directorate Level Organization

Directorate-level office (DLO) or sponsoring division/office chief, performing the design function shall:

1. Appoint Project Manager/designee
2. Provide qualified personnel equipped with adequate resources to accomplish the project
3. Ensure effective application of this design control procedure

### 2.2 Project Manager/Designee

Person responsible for the planning, definition, and timely accomplishment of a task or activity shall:

1. Assure adequacy of inputs/outputs, cognizance of affected parties, proper identification of records, and the product meets the requirements. For contracted work, this includes proper flow down of requirements and verification that the delivered product meets requirements.
2. Use concurrent engineering and product development teams (PDT) to accomplish the design process, when applicable.
3. Determine when changes to the project schedule, design requirements, available resources, interim test results, failure investigations, or other unpredictable constraints require parallel activities and/or repetition of design activities.

### 2.3 Design Review Board

The design review board is responsible for assuring the adequacy/readiness of a design or activity, assessing the design adequacy and quality, and approving or recommending redirection of the design effort.

## 3.0 PROCEDURE

The DLO leading a proposed design project will designate/establish and maintain documented design and development procedures for the project.

### 3.1 Project Initiation

#### 3.1.1 Project Type

The activity is initiated by the DLO or designated representative identifying the project's type based on the definitions of project types provided in APPENDIX A of this document. All supporting organizations for the project will use the selected project type.

#### 3.1.2 Project Implementation

The Project Manager/designee (PM) will use the design and development procedures identified in Sections 3.2 through 3.10 for all project design. Examples as to the complexity of control will vary with the project, i.e., from the very prescriptive DLO instructions for control of flight hardware/software projects to the tailored DLO-Work Instruction for R&D projects.

### 3.2 Design and Development Planning

#### 3.2.1 PM or Designee

Plan the project and prepare project plan(s) that addresses each design and development activity. Planning addresses the design and development phases and task sequence, processes (JPR 1281.9) schedules, milestone reviews, deliverables, verification and validation approaches, logistics, resource and facility usage, configuration management, data management, risk management, acquisition strategy, safety and mission assurance, project measures, environmental impacts, commercialization, and termination criteria.

1. The plan(s) will describe or reference the activities necessary to ensure the requirements of the customer (See JPR 1281.9) are met, assign responsibility for their implementation by qualified personnel and schedule for their implementation. The plan will include reference to customer specified NASA Procedural Requirements (NPR), NASA Policy Directives (NPD), and NASA standards as required for the project.
2. The plan(s) may be in any format (text, lists, checklists, tables, matrices, etc.) that clearly, yet simply, describes the responsibilities (including contracted work), resources and qualified personnel relationships.
3. The plan(s) may be in any media (e.g., electronic files posted or otherwise made available to the project team) as long as they are controlled as records.
4. As the project progresses, review and update the plan(s) using the design change process described in Section 3.10.

## 3.3 Technical Interfaces

### 3.3.1 PM or Designee

Define the technical interfaces between the different groups that make inputs to the design process, including work contracted out per JPR 1281.6.

Ensure that the necessary interface information is documented, transmitted, and regularly reviewed as part of the design review process.

## 3.4 Design Input (Record Generated, See JPR 1440.3)

### 3.4.1 PM or Designee

Determine design input requirements relating to the product and maintain records. These will include

1. functional and performance requirements; including assumptions, ground rules and constraints,
2. applicable statutory, regulatory, NASA (NPDs, NPRs, STDs, etc.), and other government agency requirements,
3. where applicable, information derived from previous similar designs, and
4. other requirements essential for design and development.

Review design input requirements for adequacy, including the intended use and expected environment for the final product.

Resolve incomplete, ambiguous, or conflicting requirements with those responsible for imposing the requirements.

Take into consideration the results of any customer agreement review activities. (When applicable, identify recommended requirements changes to the customer for review and resolution using the change process described in Section 3.10.)

## 3.5 Product Design

### 3.5.1 PM or Designee

Performs the necessary design and development activities

## 3.6 Design Output

### 3.6.1 PM or Designee

Ensures the design output is documented in a form that can be readily verified against the design input requirements and validated. The design output shall:

1. Meet the design input requirements.
2. Contain or make reference to acceptance criteria.

3. Identify, when appropriate, those characteristics of the design that are crucial to the safe and proper functioning of the product and, those special instructions which are essential to maintain the safety and functionality of the product (e.g., operating, storage, handling, maintenance, and disposal requirements).

Review and approve design output documents prior to release.

### 3.7 Design and Development Reviews (Record generated)

At appropriate stages of design and development, documented reviews of the design results will be planned and conducted. Records of the reviews will be maintained.

#### 3.7.1 PM or Designee

Determine the number and type(s) of reviews to be conducted based on the type and complexity of the project.

Determine the functions that must be represented in the review board. Include functions from pertinent organizations concerned with the design and development stage being reviewed as well as other specialist functions, as required. Appointment of actual review board members is the responsibility of each organization that performs the review.

Document and maintain the results of the review. The results are a Record and as a minimum will include the following:

1. Project identifier and type of review
2. Scope of review
3. Review board membership and attendees
4. Summary of findings, issues, and action items
5. Closure plan or closure of findings, issues, and action items
6. Signature of review board chairperson/designee indicating approval and authorization to progress to next stage

#### 3.7.2 Responsible Organization

Other review documentation, if used during the design and development review process, will be maintained by the responsible organization.

Note: The following is a listing of review types for consideration by the PM that typically are used for projects:

1. System Requirements Review (SRR) - ensures that the objectives and technical requirements are fully understood and are acceptable for establishment of the functional baseline.
2. Preliminary Design Review (PDR) - refines the design criteria to ensure requirements are met and evaluates the design concept and approach. Provides authority to proceed to detailed design.

3. Incremental or Interim Design Review (IDR) - examines the progress to date or a particular portion of the design output.

4. Critical Design Review (CDR) - provides confidence in the design output to give authority to proceed with manufacturing, hardware assembly, finalizing computer code, and creating operations documents.

5. System Acceptance Review (SAR) - ensures readiness for delivery of the system, end items, documentation, and data, and that results of verification and validation demonstrate that the product meets the input requirements under defined operating conditions.

### 3.8 Design Verification (Record generated)

Design verification provides evidence that the design output will meet the input requirements. This activity may include performing alternative calculations, showing similarity with a proven design, undertaking tests and demonstrations, and/or reviewing the design output documents before release. The method of design verification to be performed will be determined by the PM with the approval of the review board based on the type and complexity of project. The design verification activity will use the following procedure:

#### 3.8.1 PM or Designee

Identify the design verification activity to be performed at appropriate intervals of the project.

Conduct the design verification activity.

Document the results of the design verification activity. The results are a Record and will include the following:

1. Project Identifier
2. Scope of verification
3. Method of verification
4. Summary of findings, issues, and action items
5. Closure or closure plan of findings, issues, and action items

#### 3.8.2 Responsible Organization

Other documentation that describes the item verified will be maintained by the responsible organization

### 3.9 Design Validation (Record generated)

Design validation provides objective evidence, including resolution of all action items, issues, and findings, that the product meets the input requirements and intended use. Validation is normally performed on the final product under defined operating conditions, but may be necessary in earlier stages prior to product completion. Design validations follow successful design verification.

The method of design validation to be performed will be determined by the PM with the approval of the design review board based on the type and complexity of project. A design validation activity will use the following procedure:

### 3.9.1 PM or Designee

Identify the type of design validation activity to be performed.

Conduct the design validation activity to ensure the customer requirements are met.

Document the results of the design validation activity. The results are a Record and will include the following:

1. Project Identifier
2. Scope of validation
3. Method of validation
4. Summary of findings, issues, and action items
5. Closure or closure plan of findings, issues, and action items, including any constraints.

### 3.9.2 Responsible Organization

Other documentation that describes the product validated will be maintained by the responsible organization.

Note: Where tests are performed as part of verification and validation, JPR 1281.9 *Process Control*, JPR 1281.10 *Inspection and Testing*, and NT-CWI-001 *Task Performance Sheet* apply.

## 3.10 Design Changes (Record Generated)

The need and method of configuration control to be performed will be determined by the PM based on the type and complexity of project and indicated in the project plan.

All design changes and modifications subsequent to initiation of configuration control, will use the designated configuration control process that as a minimum uses the following procedure:

### 3.10.1 PM or Designee

Define the method and level of approval required for changes or modifications and obtain DLO/designee approval.

### 3.10.2 Project Team Members

Identify and document design and development changes.

### 3.10.3 Designated approval level and Customer (if affects agreement)

Review, verify, and validate with the customer as appropriate, and approve design changes or modifications before implementation. The review will include evaluation of the effect of the changes on constituent parts and delivered product. Maintain records of the results of the review and any necessary actions.

## 4.0 RECORDS AND FORMS

Records:

1. Requirements review records
2. Design review records
3. Design verification records
4. Design validation records
5. Design and development change review records

Forms:

None Identified

## 5.0 FLOW DIAGRAM

None required.

## APPENDIX A. DEFINITIONS

| Term | Definition |
|---|---|
| Design output: | Result of the design process, such as drawings, software design documents, specifications, plans, procedures, analyses, and documentation for prototyping as well as all finalized and approved drawings and documentation for manufacturing the product. |
| Design process: | An organized effort by technically trained personnel to create a design output that will produce a defined result in accordance with the customer. |
| Projects: | Projects are specific activities having defined goals, objectives, requirements, life-cycle cost estimates, a beginning, and an end. Project planning will include documented, controlled agreement(s) between affected parties, which describes how a project is to be managed and controlled. All projects that are within the JSC Quality System must follow this JPR for design and development. The following are definitions of project types: |
| | Ground Hardware or Software Project: Hardware or software development activities leading to a specific end item in support of a mission critical facility or operational function |
| | Research and Development Project: Hardware or software development activities leading to a specific end item for test or demonstration of a design concept |
| | Flight Hardware and Software Project: Safety critical or mission success hardware and/or software provided for flight. Includes hardware and software designated for flight that is not safety critical or an impact to mission success (e.g., DTO, DSO, flight experiments) |
| | Aircraft Hardware and Software Project: Hardware or software design activities leading to modification of aircraft |
| Verification: | Confirmation of the design by examination and provision of objective evidence that specified requirements have been fulfilled. |
| Validation: | Confirmation by examination and provision of objective evidence for a product that the particular requirements for a specific use are fulfilled. |

## APPENDIX B. ACRONYMS

| Acronym | Term | Definition |
|---|---|---|
| CDR | Critical Design Review | |
| DLO | Directorate Level Office | |
| DSO | Detailed Supplemental Objective | |
| DTO | Detailed Test Objective | |
| IDR | Incremental Design Review<br>Interim Design Review | |
| JDMS | JSC Directives Management System | |
| JPR | JSC Procedural Requirements | |
| NPD | NASA Policy Directive | |
| NPR | NASA Procedural Requirements | |
| PDR | Preliminary Design Review | |
| PDT | Product Development Team | |
| PM | Project Manager | |
| R&D | Research and Development | |
| SAR | System Acceptance Review | |
| SRR | System Requirements Review | |
| STD | Standard | |
| | | |

## APPENDIX C. SLP 4.4 CHANGE LOG

| Rev | Date | Originator | Description |
|---|---|---|---|
| Basic | 03/06/97 | Nick Lance | Initial Release |
| A | 8/29/97 | Nick Lance | Changes to incorporate:<br>a) configuration management (in section 5)<br>b) tailoring requirements (para 7.2) cited in NQA document review<br>c) clarification of requirements for design and development plan (section 5), potential inapplicability of review of customer agreement, and editorials to enhance flow of procedure. |
| B | 10/29/97 | Nancy E. Munoz (x39015) | Changed SLP # from 4.4-1 to 4.4<br>Deleted SLP 4.4-2 reference in section 3 and para 7.13.<br>Deleecame step 7.10.5.<br>Reordered para 7.12 as 7.10 and 7.13 as 7.11.<br>Para 7.16 renumbered as 7.13, and reworded for clarity, and added characteristics statement.<br>Added “special instructions” to new paragraph 7.18.<br>Deleted note in para 7.20, and renumbered to para 7.17.<br>Deleted reference to maintaining quality records in sevted text in parenthesis in para 5.5.<br>Added definition in para 5.11.<br>Added agreement sentence to 7.9.<br>Deleted first sentence in para 7.9.1, and added the word detailed.<br>Added software design documents in para 7.9.2.<br>Deleted “customer” from “customer agreement” throughout document.<br>Deleted para 7.14.<br>Combined original para 7.10 and 7.13 and made it 7.10 Design Reviews.<br>Incorporated elements of SLP 4.4-2 Design Reviews into paragraph 7.10, section 4, 5, 6, and the flowchart.<br>Step 7.12 beral places, and in section 4.0 to better represent the required records in the ISO 9001 standard.<br>Changed Directors to DLO in section 6 and throughout document. |
| C | 1/08/99 | Nancy E. Munoz (x39015) | Major Rewrite of entire document. |
| D | 12/08/00 | Nancy E. Munoz (x39015) | Incorporate quality records requirements for ISO 9001:2000. Additions to sections 4 (a & d), 7.4 & 7.10. Changed “agreement sponsor” to “customer” to be consistent with SLP 4.3, and deleted definition of an agreement in para 5.6. |
| E | 11/16/02 | Nancy E. Munoz (x39015) | Incorporate reference to SLP 4.6 for contracted work, and reference to NPD and NPG in section 7.2 and 7.4. |
| F | 03/2006 | Steve Schenfeld (x47753) | Incorporated clarification to address requirements and terminology in SAE AS9100. |